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Vol. VII. No. 4

Hydro-Electric Power Commission of Ontario

APRIL 1920

QUEENSTON-CHIPPAWA POWER DEVELOPMENT
—*Photo from Popular Science Monthly*

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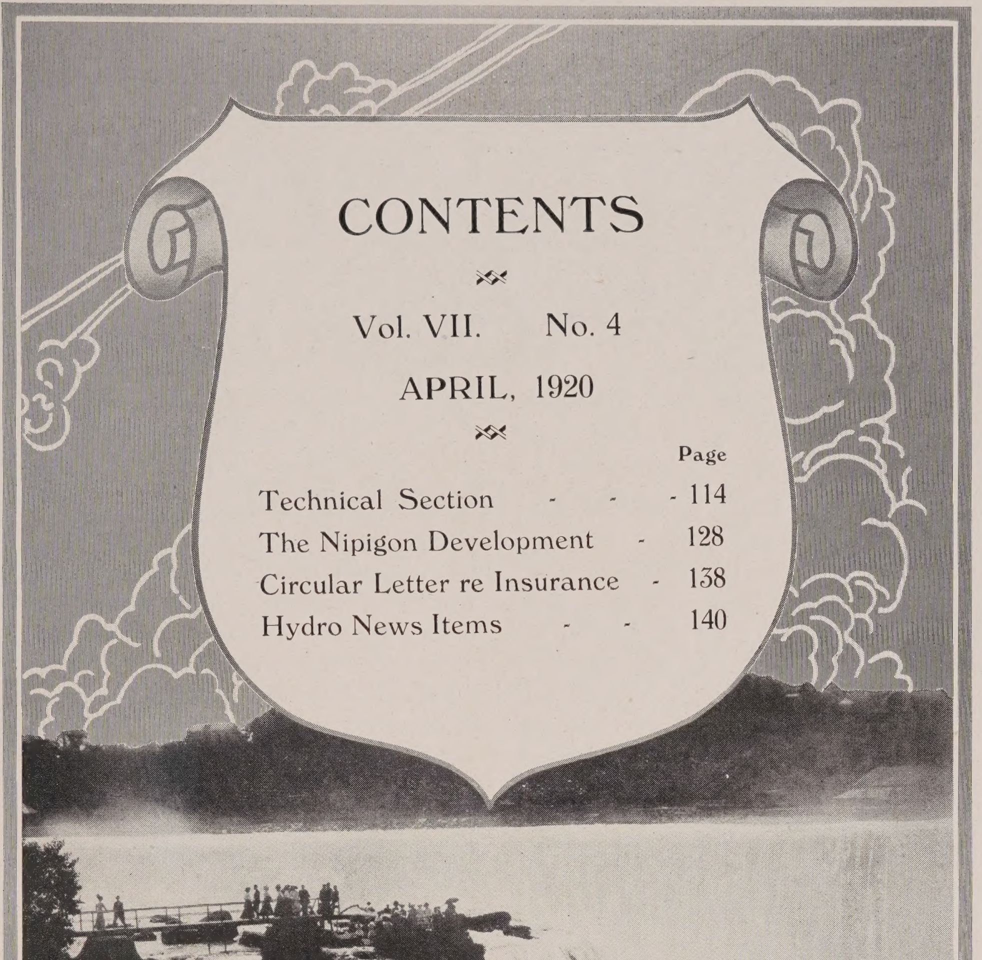

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The Lincoln Demand Meter

IN the March, 1919, issue of THE BULLETIN an article was written on the above subject by Perry A. Borden, of the Commission's laboratories. Since that date the meter has passed the development and experimental stages, and is now manufactured by the Lincoln Meter Company, of 243 College street, Toronto, for general use in Canada. This company is now ready to take care of the market in this country for all meters of the indicating type.

The Commission, anticipating the needs of the Province, recently placed a stock order for a large quantity of meters rated at various standard voltages up to 500-volt. Municipalities desiring to secure any number can have their orders promptly filled by the Commission. Furthermore, a preferential price was secured by the Commission in consideration of the number purchased, and this will be extended to the municipalities. Orders may be placed by the municipalities directly with the Lincoln Meter Company, and their orders will be properly executed. Due credit will be allowed the municipalities for orders thus given, as arrangements have been made with the company to fill such orders from the Commission's stock order.

Like every new invention, it is expected that there will be the dubious prospective buyer, who comes "from Missouri." At this juncture an educational program seems to be in order, to indicate advantageous points of the meter. The reason for the present restricted use of this meter is not due to the lack of potential possibilities or probable application, but more particularly, as above stated, to the present stage of its history. A little impetus might be given to the application of this meter for commercial use, and one purpose of this article is to accomplish something tangible in this direction, as it is thought to be for the general good of the electrical industry to keep abreast with its up-to-date invention.

We also hope to be excused for a repetition of any statements or explanations formerly expressed in THE BULLETIN or elsewhere. It must be admitted that a good story will stand

repeating. We therefore hope to accomplish something by repeating in some measure what has already been said regarding this meter.

The principle upon which this meter is constructed is one involving the laws of heat. Only one other type of electrical meter has ever been used that in any measure involves the principles used in the Lincoln meter. This was the Wright Demand Meter, which met with only a limited measure of success, and was used as an ammeter.

The inventor considered that the idea of constructing a demand meter based upon the heat principle, was worthy of investigation, and set to work a number of years ago to experiment with various methods of achieving the end in view. Some of the earlier models were constructed, involving the use of the principle of expansion of liquids due to heat. The final design, however, replaced the use of liquids by metallic elements, the foremost feature of which is the action of heat upon bimetallic springs. The inventor secured patents on the meter in Canada in 1915 and 1916. After an experimental stage, and after considerable investigation, which was carried out with great thoroughness, a company was formed in October, 1918, known as the Lincoln Meter Company Limited, with head office and factory at 245 College street, Toronto.

The meters are at present built self-contained for 500, 200 and 100 volts, with a current rating of 5 amperes for each current coil. The meters have a 10-minute time period which will have more specific explanation at a later stage in this article. Provision on the dial of the meter is made for inserting the full scale reading of the meter in watts which depends upon the voltage rating of the meter, and instrument transformers used with it, if any. For a 100-volt meter the full scale reading is 1,000 watts. For a 200-volt meter the full scale reading 2,000 watts. For a 500-volt meter the full scale reading is 5,000 watts. In case potential or current transformers, or both, are used with the meter, full scale reading is increased thereby.

Provision is made on the dial to mark the current transformer ratio on the left-hand lower corner and potential transformer ratio on the right-hand lower corner. It is desired that the manufacturer should know the above ratios so that these markings, together with the scale multiplier, may be placed on the dial before leaving the factory. The meter has a universal use on alternating current circuits, being equally adaptable for 25 as well as 60-cycle circuits. It has two wattmeter elements and can be used as single-phase, two-wire, 110 or 220-volt meter; three-wire, 220-volt meter; two or three-phase meter, it being only necessary to select the proper voltage for each specific case.

Reference to Figure 1 will assist the reader in understanding the action of the meter. Heat is produced by current passing through two resistance elements R_1 and R_2. In the case of a polyphase meter R_3 and R_4, also shown in Figure 1, are used. They would be similarly connected to circuits and form the other phase

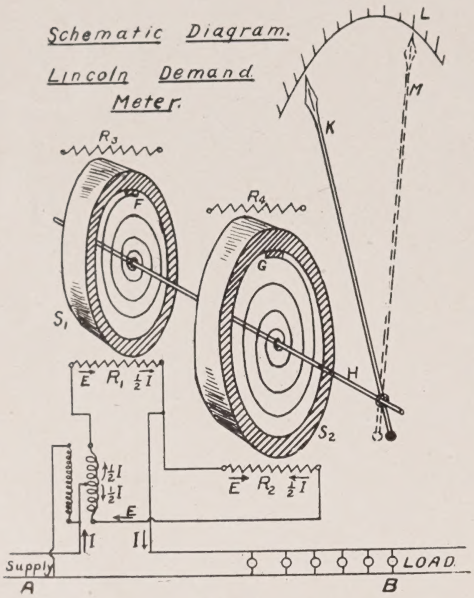


Figure I

of the meter. In order to have uniformity in meters and low production cost, the manufacturer has decided to make only one style, which contains the four resistances and by means of external connections it can be used on single or polyphase circuits, thus giving a more universal use. Explanation of the manner of connecting the meter for various circuits is subsequently explained in this article. Heat produced in these resistance elements is conducted to two metallic cylinders, S_1 and S_2. Each cylinder has a resistance element attached to each of its ends, while in the figure they are shown as if attached to the side, it being admittedly difficult in such a figure to give a true representation of the location of all parts. Within the cylinders are the specially constructed spiral springs, F and G, which, under the influence of heat imparted to the cylinders by the resistance elements, produce the torque on the shaft H. The pointer K is rigidly attached to this shaft and registers demand which is proportional to this torque. These springs consist of two metal substances, one being brass and the other a special alloy. These two substances, having a different expansion coefficient and being welded together in the form of a spiral spring, tend to unwind with rise of temperature. Reference to the figure will show that the outside ends of these springs are attached to the side of the cylinders at F and G, but it is especially noted that the spring F is coiled counter clockwise to the centre, while spring G is coiled clockwise to the centre. The springs tend to produce opposing torque by such arrangement and consequently only a difference in temperature of one cylinder from the other will cause a change of torque, and the shaft will accordingly be turned to a new position depending on the amount of difference in temperature that is maintained. The pointer will indicate on the scale this action, which is a slow action, as it is quite evident that some time is required to register the full change of temperature within the cylinder by the application of heat from the resistance elements. The time required, which is the vital feature in determining the time constant (10 minutes being adopted by the Lincoln Meter Company for all meters manufactured in Canada), depends chiefly upon the amount of heat capacity contained in the cylinders and springs. More metal in these cylinders would require a longer time to raise them to a given temperature, and give a

longer time period to the meter. In this manner is the time period of 10 minutes obtained. A further inherent characteristic confronts one when making investigations into the action of the meter. This characteristic is due to the loss of time in conducting the heat from the resistance through the cylinders to the springs. This has been expressed as a time lag and will be evidenced to one who wishes to apply a load to one of these meters, when he will observe that the pointer will not begin at once to register, and will continue to move forward for a short time of approximately 15 seconds after load is disconnected.

In the foregoing no description or explanation of the electrical circuits has been given. The potential circuit is connected to a small transformer C with a very low voltage secondary coil. This secondary coil is connected in series with the resistance elements R_1 and R_2. When potential is applied to the meter but no load exists on the lines, the same current is flowing in each resistance element R_1 and R_2 and an equal amount of heat is imparted to each of the cylinders S_1 and S_2, and consequently equal opposite torque in each spiral spring is produced. The current I, due to load B, divides and flows over two parallel circuits. One-half of the secondary coil of transformer C and one of the two resistance elements are included in this circuit. It is also observed that the direction of flow of the load current through the resistance elements, as shown by the arrows, is different in R_1 from that of R_2.

If we represent the current in the resistance elements arising from the potential circuit as E, and the current arising from the load as I, one-half of which flows in each resistance element, we have $E+\frac{1}{2}$ I amperes flowing in R_1 and $E-\frac{1}{2}$ I amperes in R_2. The heat produced in these resistances is proportioned to the square of the above amperes, and since these amperes are different, a greater heat is produced in R_1, which will cause a temperature difference between S_1 and S_2 and produce a torque due to the action of the bi-metallic spiral springs enclosed. This difference in heat in the two elements is relative to the quantity:

$$(E+\tfrac{1}{2}I)^2-(E-\tfrac{1}{2}I)^2 2 = 2EI,$$

which is a measure of power.

Power factor is taken into account in the above, although this may not be obvious to all. This may be concisely shown by pointing out that the value represented by E and I in the above expression are instantaneous values of voltage and current respectively. However, the following graphic proof will convince the reader. In Figure 2 assume AB = E, the effective value of current in the secondary potential circuit and relative in value to the voltage on the line delivering the power; assume CD = I, the effec-

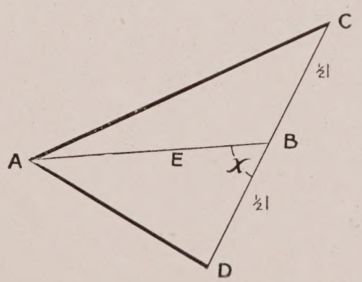


Figure 2

tive load current which is out of phase with the current E due to voltage by an angle X where cos. X = Power factor; and assume BD = BC = ½I. AC and AD are the resultant currents in the resistance elements R_1 and R_2 respectively (Figure 1). Heat produced in R_1 will be proportional to AC^2. Heat produced in R_2 will be proportional to AD^2. Torque from the springs will be proportional to $AC^2—AD^2$

$= (AB+BC \cos. X)^2+(BC \sin. X)^2—(AB—BD \cos. X)^2—(BD \sin. X)^2$

$= 2AB..CD \cos. X$

$= 2$ EI cos. X, where E and I are effective values,

= Power.

As the power factor decreases the angle X increases, AC diminishes, and AD increases. When $X = 90°$ AC and AD are equal; that is, equal currents flow in R_1 and R_2 respectively, and no registration is made and the power factor is zero. With increased power factor the angle X decreases, AD becomes less, while AC increases. When X = zero AD becomes zero and AC = AB+BC and power factor is unity. The value AB is made approximately equal to BD with full rated load. This is adjusted by design of the secondary potential circuit by the manufacturer.

The scope of this article does not allow a discussion of any length upon the theory or heat laws upon which the meter is based. The above simple detail explanation serves as a general guide to those curious to know what makes the meter indicate. To those who wish to become more acquainted with the principles applied, we would refer to the inventor's article entitled "Rates and Rate Making" Transactions of the A.I.E.E., volume XXXIV, page 2279.

The characteristics of this meter under various types of loads is also an exhaustive study, and a very interesting one. It is not feasible to deal adequately with this phase of the subject here. It is sufficient to state that the meter will indicate 90% of an applied load maintained at a constant quantity in the first time period (10 minutes). At the end of the second time period the meter registers 99%, and at the end of the third period 99.9%, etc. A complete description of an exhaustive study of this subject is presented in a paper by the inventor in Transactions of the A.I.E.E., Volume XXXVII, page 189.

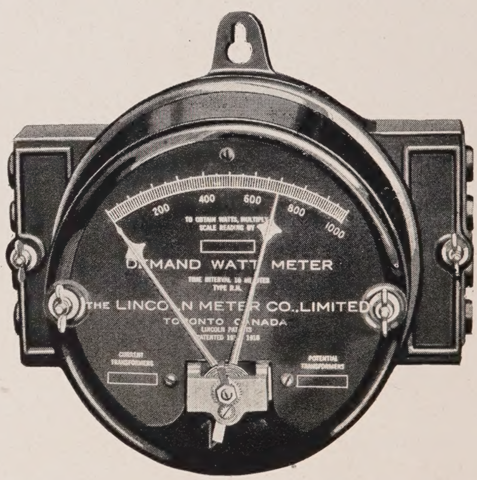


Figure 3

The above Figure 3 shows a full-face view of the meter as manufactured in Canada. The terminal blocks are arranged at the sides of the meter. The cover is of glass, made dustproof by use of a felt washer and attached to the meter case by use of wing nuts. The meter

can be sealed by government seal. Two pointers are used; the one pointer (red), which is rigidly fixed to the shaft H (Figure 1), indicates the average load for the preceding period; the other pointer (white) is pushed forward by a lug attached to the first mentioned pointer and remains at the highest point until reset.

The white pointer permits of resetting by carefully turning the screw located in a rib at the bottom of the meter. The results of this action can be better seen by referring to the sectional view shown below. Care should be taken not to force the white pointer back beyond the red pointer, as it is sufficient to bring it into line with the Red pointer only, and not attempt to set it back to zero.

Figure 4 shows a view of the Lincoln Meter with case in sections and parts in elevation.

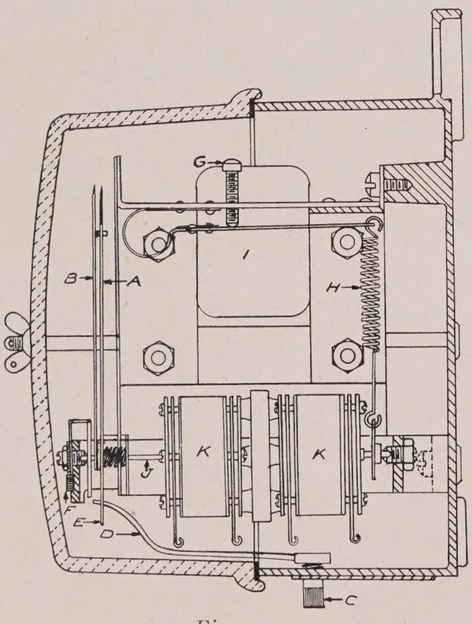


Figure 4

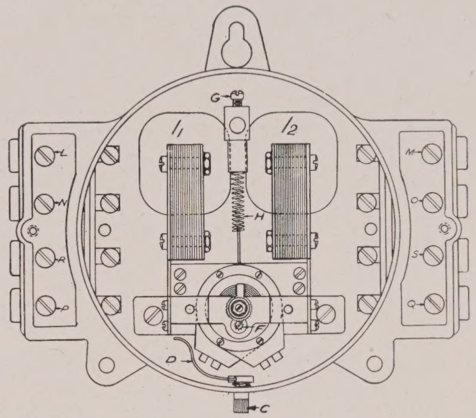


Figure 5

Figure 5 is a plan of the meter with cover, dial face and pointers removed.

A.—The pointer, which shows the maximum load which has been applied to the instrument since it was last reset.

B.—Driving pointer. This pointer indicates the average load for the immediate preceding time period and causes pointer A to move upwards on the scale on each occasion when the load is above that which had been previously applied to the meter.

C.—Thumb screws for resetting the maximum pointer. In the latest models a small spring causes C to automatically return to the sealing position after the pointer has been reset. A small hole will be found in the casting through which the sealing wire should be inserted to prevent any unauthorized individual resetting the pointer.

D.—The resetting arm, which comes in contact with the reverse end of the maximum pointer when C is turned through an angle of approximately 30 degrees. Should a load be on the meter when pointer A is reset, care must be taken not to force it

back beyond pointer B. This can be guarded by moving the thumb screw C slowly.

E.—Is the reverse end or counterweight of the maximum pointer and, by referring to Figure 5, C, D, E, the action of the resetting can readily be seen.

F.—Zero adjustment. After the meter has had potential applied to both potential coils for a period of 24 hours, the pointer B should read within one division of zero. If this is not the case, by turning the pinion F with a screw-driver in a clockwise direction the pointer B will be caused to read lower and if F is turned in a counter clockwise direction the pointer will read higher.

G.—Full load adjustment. Apply any convenient load between 50 and 100%. Maintain this load at a steady point on the indicating wattmeter. At the end of 20 minutes the scale reading should be 99% of the applied load. If the reading is not correct, screw G should be turned in a counter clockwise (up) direction to decrease the scale reading or in a clockwise (down) direction to increase the scale reading.

It will be noted that when the cover is removed a movement of the pointer is apparent, although the load is maintained constant. This is due to the fact that when the cover is removed the air circulation within the meter is upset, therefore it is desirable to keep the cover off for as short a time as possible and to wait for 10 or 15 minutes before again taking a reading. This allows correct heating conditions within the meter to re-establish themselves.

H.—Full load adjustment spring. This spring is expanded or contracted by the operation of screw G and according to its position retards to a greater or a less degree the movement of the spindle.

I.—I_1 and I_2 refer to internal transformers. I_1 is connected to the top phase and I_2 to the bottom phase. These transformers contain the potential and current windings and their operation has been described in a previous part of this article.

J.—Is the spindle of the meter, upon which are mounted the two bimetallic springs and the driving pointer. It is made of tool steel, with ground ball-nosed pivots and nickel finished to prevent rust.

The spindle J is carried in a top and bottom of phosphor bronze. End play of $^1/_{32}$ of an inch should be allowed in adjusting these screws in order to take care of the expansion of spindle J when the meter is under load.

K.—The two cylinders which contain the bimetallic springs. It can be seen from the drawing that heaters are attached to each end of this drum. The two outside heaters being for one phase and the two inside heaters for the other phase or in the case of two wire, single-phase, by means of external connections on the meter, the two pairs are placed in series.

Terminals for three-phase connection without transformers:

L	Line Current	Phase	I
M	Load	" "	I
N	Potential	"	I
O	Potential	"	III
R	Potential	"	II
S	Potential	"	III
P	Line Current	"	II
Q	Load "	"	II

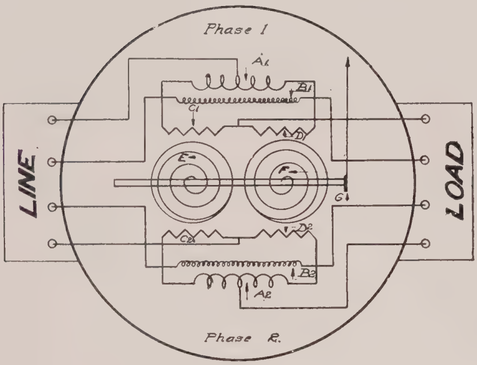


Figure 6

The meter manufactured for use in Canada is virtually a polyphase instrument, as previously mentioned, and has universal use. Figure 6 shows an outline of the internal meter circuits and should be helpful to those installing the meter, giving them a better understanding of the polyphase connections. A_1 and A_2 are the current circuits or coils, B_1 and B_2 are the potential circuits. The two top connections on each side are the terminals of one phase of the meter. The two bottom connections on each side are the terminals of the other phase. E and F are the back and front bimetallic spiral springs. D_1 and D_2 are the front resistance elements. C_1 and C_2 are the back resistance elements. G is the pointer shaft.

The following are a few helpful connection diagrams showing six different loads that can be measured. Voltages of these circuits are not expressed, as it is expected that a meter of proper voltage will be applied in all cases. The frequency of the circuit may be either 25 or 60 cycles as previously stated.

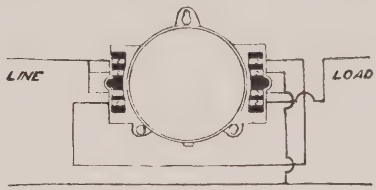


Figure 7

Figure 7 shows a simple connection diagram for use on two-wire, single-phase circuits. The current circuits are placed in series, while the potential circuits are in parallel. The meter thus arranged would have 5 amperes capacity.

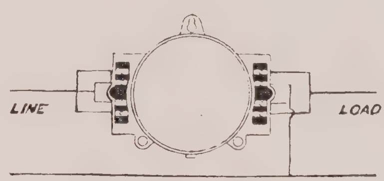


Figure 8

Figure 8 shows the meter used on a similar circuit to that in Figure 7, but currents are placed in parallel. This gives a capacity of 10 amperes.

Figures 9 and 9a show the three-wire, single-phase circuits with the meter used as a three-wire meter. In Figure 9a current transformers are used. The potential coils are shown in series with the neutral tied to the

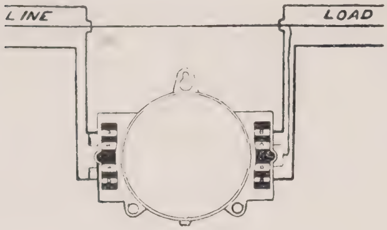


Figure 9

middle point. The current coils are placed in their respective outside wires. This arrangement of potential circuit permits of registration accurately since it takes care of unbalancing.

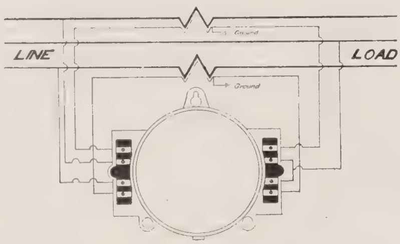


Figure 9a

Figures 10 and 10a show a three-wire, single-phase circuit with the meter used as a three-wire meter. In Figure 10a current transformers are used. The potential coils in this figure are shown in parallel across the two outside lines. Neutral wire is not tied in. Current coils are placed in their respective outside wires, and the meter is used in this instance in every respect similar to a standard three-wire, 220-volt meter, except that there are two potential, coils instead of one, as is found in a standard three-wire meter. It is also obvious in this instance that the potential rating of the meter is of necessity double that as illustrated in Figure 9.

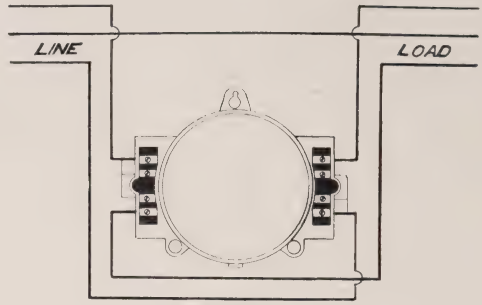


Figure 10

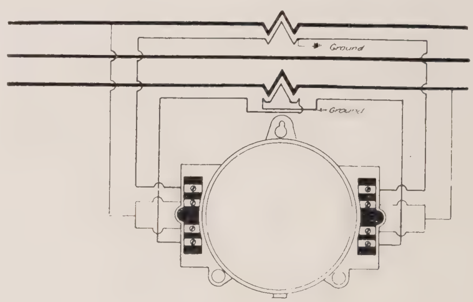


Figure 10a

Figure 11 shows cut of the three-wire transformers for use on commercial leads. The advantage of using a three-wire transformer in place of 2 two-wire transformers is the added simplicity of installation, and the investment for the outfit is consider-

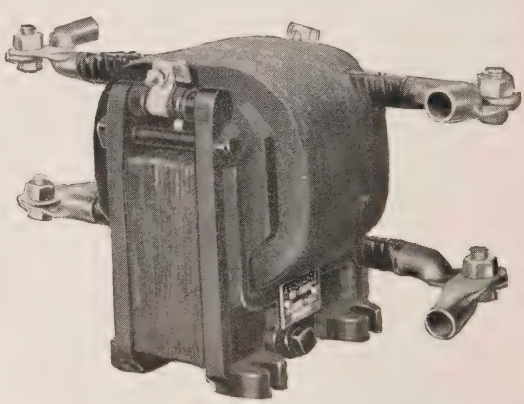


Figure 11

ably lower. These special transformers are produced by the Lincoln Meter Company.

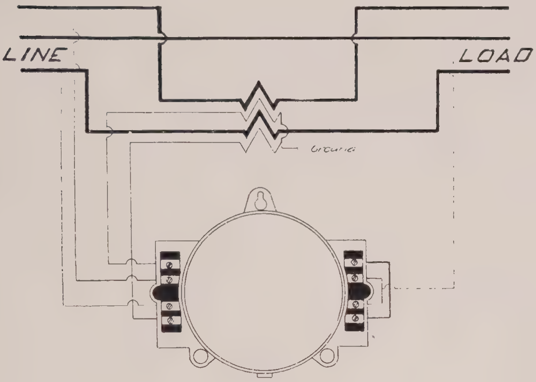


Figure 12

Figure 12 shows the diagram of connections for use on three-wire circuits with three-wire transformer, using a 110-volt instrument with the potential coils in series tied to the neutral.

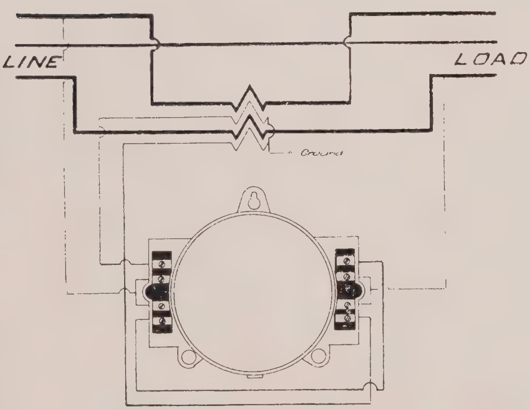


Figure 13

Figure 13 is the diagram of connections for using a 220-volt meter with a three-wire transformer, the potential coils being in parallel across the outers. This latter arrangement follows more closely the standard practice for three-wire integrating watt-meters.

The next three figures show the meter on three-phase circuits, without transformers in Figure 14, with current transformers in Figure 15 and with current and potential transformers in Figure 16.

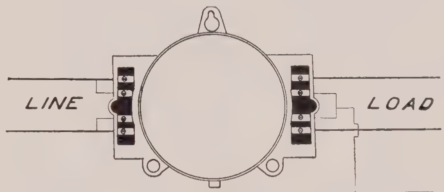


Figure 14

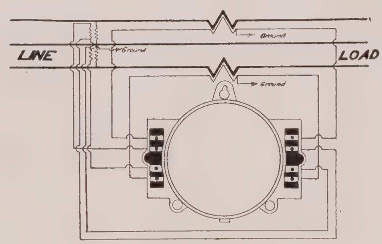


Figure 15

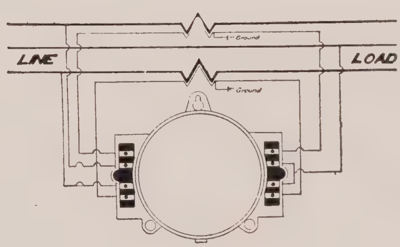


Figure 16

The metering requires very little energy to operate it. The watts consumed by each potential coil at normal voltage run from 2 to 2.5. The watts consumed by each current coil at full load are .12. The meter is not

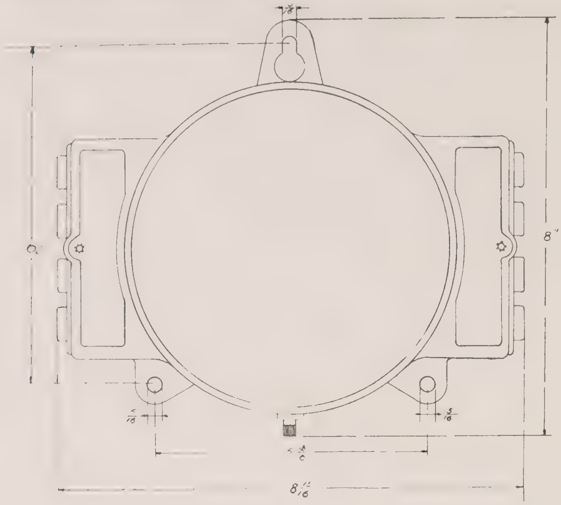


Figure 17

meter is very rugged, and with ordinary treatment will maintain its accuracy. It has no moving parts except the slow moving shaft and pointer. In this respect it should give little cause for trouble.

The meter presents a sufficiently pleasing appearance to be used for switchboard mounting, although it is not specially constructed for switchboard use.

affected to any extent by change of atmospheric conditions. Tests were made over a wide range of room

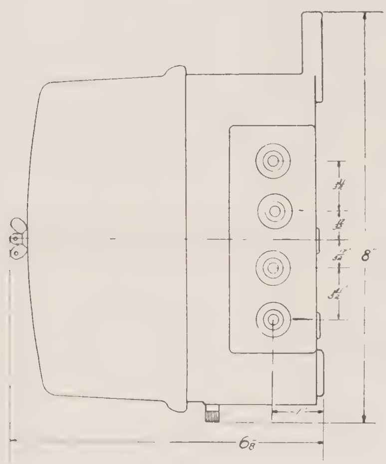


Figure 18

Dimension Diagrams

temperature from —10° F. to 125° F., the error over this range of temperature being approximately 3%, which compares favorably with standard meters of the induction type. The

Commercial Application and Revenue Producing Features

The dry goods merchant measures his product with a yard stick, and the butcher uses the scales, but the electrical man finds it more difficult to measure his product for the purpose of determining a charge.

In the early days they did not measure electricity, but allowed it to run freely like water, and made a flat rate charge. Realizing this encouraged extravagance, the engineering profession came forward with a meter to measure the energy consumed, and the customer, realizing that it was to his advantage to practise economy, adopted a policy of of using the electric energy only at times when he wanted it. This called for further consideration on the part of measuring electricity. Immediately the terms diversity, load factor, peak load, etc., came into the limelight of the electrical industry, and the electrical profession had a more complex

problem of measuring on their hands. It was soon realized that one cost arose out of the electric energy used, and another one arose out of how it was taken. These two ideas have become commonly known to-day as the "Consumption Charge" and "Service Charge" respectively.

"Consumption Charge" is readily and accurately determined by measuring the kilowatt hours used. Meters for measuring the energy in kilowatt hours have reached a highly perfected stage, and are guaranteed to be accurate within a definite range. Moreover, an effective system of government inspection is in force to protect the public from improper charging. On the other hand, however, we have been generally disposed to base our service charge on a guess. At best it is only a rough estimate. It would seem folly to be so exacting in one portion of the customer's bill when the other might be considerably wide of the correct amount.

The Commission has adopted a basis of rate-making which involves up-to-date principles, but it would seem from the above that the art of rate-making had outdone the art of metering. The need for a meter of a type similar to that of the Lincoln Meter Company is great. With the use of such a meter the customer's demand and his service charge will no longer be estimated. The cost of other demand meters, and the complications attending their use have stood in the way of their universal application. The Lincoln Meter Company has brushed these obstacles aside, and it is expected that a great number will be used where conditions heretofore made the use of demand meters prohibitive.

On standard power services, the utility managers can profitably connect one of these meters on small installation. The added cost of metering on such an installation is a minor amount, and he is often many times repaid for this extra expense by additional revenue from more accurate indication of demand. The following are a few tangible results actually experienced.

Instance 1.

Former demand assumed....25 H.P.
Registered demand by Lincoln meter....51 H.P.
Annual revenue increase....$390.00

An electrical heating appliance not recorded caused the extra demand.

Instance 2.

Former demand by indicating meter test....59 H.P.
Registered demand by Lincoln meter....98 H.P.
Annual revenue increase....$585.00

Instance 3.

Demand claimed by customer....100 H.P.
Registered demand—Lincoln meter....141 H.P.
Annual revenue increase.. $800.00

Instance 4.

Installed capacity in motors.... 55 H.P.
Registered demand—Lincoln meter.... 38 H.P.
Annual saving to customer, $200.00

In the latter instance, the peak load of the municipality occurs when the customer is taking power. The presence of the Lincoln Meter pro-

vides an incentive to improve load factor, and, incidentally, to lessen the billing peak in favor of the municipality. Thus both customer and local utility have benefitted by the careful control of demand.

In metering installations for power customers, two single-phase watthour meters of 5-ampere capacity may be used in place of a three-phase watthour meter. A number of utility managers may have a quantity of single-phase watthour meters that could be profitably placed in use this way. Several installations of this type are in use, and have been very satisfactory. The power factor of the load on these installations is determined by these watthour meters. In general in such installations, current transformers are needed for the Lincoln meter if the load is of any size, and this permits of using watthour meters of 5-ampere capacity.

On commercial customers' loads the Lincoln Meter will find a large field of use. In this class of business the connected load is not kept thoroughly checked. Quite frequently in looking over records of billing commercial customers, one finds an impossible condition. From these records it can often be proved there are more than twenty-four hours in a day. A Lincoln Meter will correct these conditions and amply pay the utility manager for the cost of metering this demand. In many commercial installations it is very difficult to determine the demand or connected load for billing basis. In one Ontario city where a large government office takes power under a commercial contract, a Lincoln Meter has been mounted on the switchboard in the basement of the building. This has been in operation for several months, and the customer has expressed his satisfaction at this arrangement. Previous to the installing of the Lincoln Meter there was continued dispute with the customer over the connected load to be used for billing purposes. In this large office building the inspector met with all sorts of electrical appliances, such as fans, adding machine motors, dictaphones, pump motors, elevator motors, lights in various offices, some of which were used during the day and others were used at night. All the work of periodically checking by an inspector the connected load in this office building has now been eliminated, and a saving in time has been made. Electric heaters are used profusely these days in Hydro towns, where the rates are low. These appliances are finding favor in the stores and offices, and it is often difficult to check up these and other appliances because of the ease in which the customer can conveniently keep these in an obscure location—they are therefore often missed by the inspector checking up the connected load of commercial costomers. but a Lincoln Meter would be the remedy for such cases. Hotels and public institutions are often the cause of much thought and argument in an effort to settle the connected load for billing purposes, and a Lincoln Meter should be a welcome solution of the differences between utility manager and customer in such cases.

Just how small an installation on which a Lincoln Meter should be installed is probably a problem for the utility manager. It would seem

justified in all cases where extra revenue will cover 12 to 15% of the cost of installation. It will eliminate any possibility of error in obtaining the connected load, and while there may not often be immediate returns from installing the meter, it is very probable that in time the increased demand recorded by some appliance which would be otherwise negelcted, will compensate the utility manager. It must be further observed that small commercial customers with 10-ampere services or under can be metered without the added cost of the instrument transformer. Too much cannot be said of the advantage of its use in the commercial department. One municipality proposes to install a large quantity on the commercial services. The manager is aiming chiefly at checking up the use of portable heaters on commercial services. Practically every municipality could well afford to have one of these meters to be used as a portable instrument for miscellaneous uses, such as obtaining maximum demand on transformers, checking up power loads, commercial installations, etc.

The Lincoln Demand Meter is essentially a Canadian product. Of the 146 parts composed in the assembled meter, all except 4 parts are made in Canada. The glass cover, the winding of the potential coils, the hair spring for zero adjustment, and raw material of the bimetallic springs are obtained from the United States. The manufacturer has equipped his factory with a complete set of jigs and dies constructed after much experiment, and costing approximately seven thousand dollars. The appearance and construction of the meter is equal to any high grade electrical instrument on the market. It represents in all one more step in the art of electricity, the electrical profession having passed one more milestone in its progress.

The Nipigon Development

THE DEMAND for the use of electrical energy in New Ontario having become such that additional generating capacity was found a necessity, the Commission, at the urgent request of the municipalities in the Thunder Bay District, viz., Port Arthur and Fort William, has undertaken the construction of a large development on the Nipigon River at Cameron's Falls, with provision in the initial installation to take care of the immediate power requirements and with plans so arranged as to permit extensions to be made from time to time as the occasion demands.

The construction of new terminal grain elevators, the demands for power for pulp and paper industries, and the possibilities of the mineral resources of the district, as well as the rapidly increasing loads in both cities, were indicative of a demand far in excess of the available capacity of the only existing source of supply—the Kaministiquia Power Company, and the necessity of making provision for the immediate demands of the future caused considerable anxiety to the local authorities. After careful consideration a solution of the problem was finally secured by the assistance of the Hydro-Electric Power Commission of Ontario, the ultimate result being a decision to proceed at once with the construction of the of the Nipigon Development.

The City of Port Arthur is being served at the present time with electrical energy through the medium

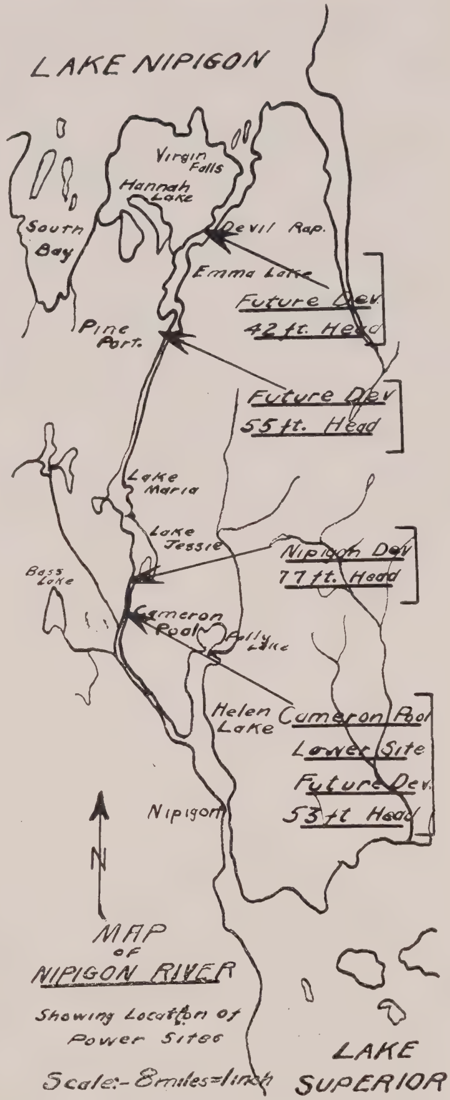
Intake of Temporary Development

of the Hydro-Electric Power Commission of Ontario, under an agreement between the latter and the Kaministiquia Power Company, bearing date of September 9, 1909, and an agreement between the municipality and the Commission running concurrently with the power company's agreement, both of which expire in December, 1920. These agreements provide for a supply of power up to 10,000 horsepower, any excess of this amount necessitating additional development.

During the period of preliminary investigation concerning the future power supply of this district, considerable attention was given to a development at Silver Falls, near Dog Lake, on the Kaministiquia River, located approximately thirty miles west of Port Arthur. This scheme was abandoned, however, due to the ultimate capacity being limited to a maximum of approximately 25,000 horsepower.

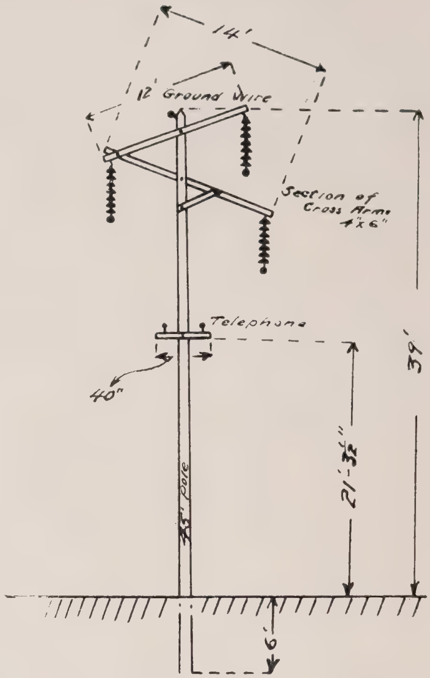
Lake Nipigon, with an area of 1,500 square miles, provides an ideal natural storage basin for this development, whereas the total drainage area of the Nipigon River, including the Lake, approximates 9,100 square miles; the maximum stream flow of the river approximates 3,600 second-feet without regulation; with regulation on Lake Nipigon, however, 5,800 second-feet is obtainable for the operation of the completed development at 75 per cent. load factor, thus assuring ideal conditions from a hydraulic operating standpoint.

Neither the Kaministiquia Power Company nor the abandoned scheme of development at Dog Lake (both of which are located on the Kaministiquia River) is capable of taking care of high load factor loads such as pulp and paper mills to the same extent as the various possible developments on the Nipigon River, due to greater variation of stream flow and much smaller drainage area.

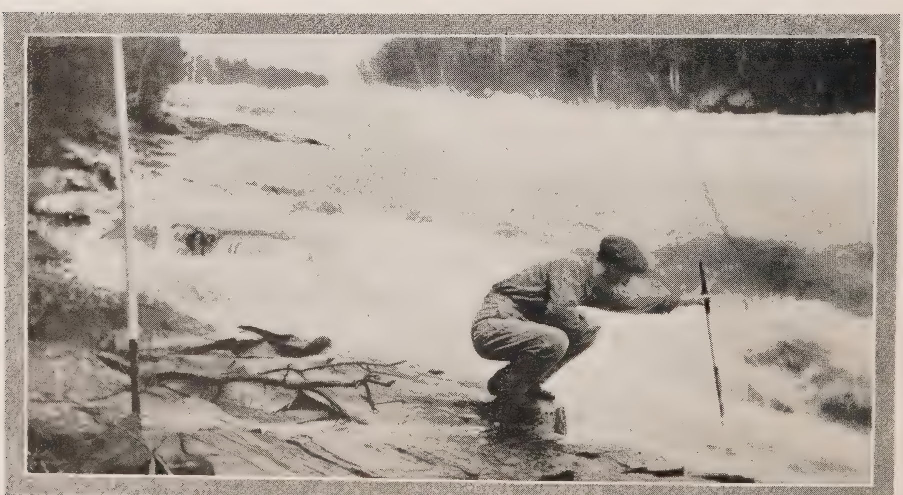


As the demand on the Kaministiquia Power Company was approaching the ultimate capacity of the development, and as the requirements of the Twin Cities could not be adequately provided for from this plant in addition to prospective pulp and paper mill loads, and, furthermore, as the Dog Lake Scheme did not permit provision being made for sufficient power for future increase in demand, nor provide for supplying energy to the various high load factor loads which would form future requirements, it was quite obvious that the Nipigon site should be adopted, and arrangements were perfected after due consideration for starting the work immediately.

Although Cameron's Falls is located at a greater distance from the Twin Cities than Silver Falls, thus necessitating a longer transmission line from the former source, yet it was considered that the available capacity of the various sites on the Nipigon River, including Cameron's Falls, would provide for the needs of the



Standard Pole,
Nipigon-Port Arthur Transmission Line



Cameron's Falls, Nipigon River

Tail-race, Main Development, showing Railway Bridge in background

district to better advantage, as the demands of the class of load peculiar to the neighborhood were such that it would be only a question of time when the Silver Falls development would be inadequate to meet all conditions and the ultimate result would involve a further development on the Nipigon River.

By-laws were submitted in Fort William and Port Arthur on January 1, 1917, authorizing the execution of an agreement with the Commission covering delivery of power from the Nipigon Development, and were carried almost unanimously in both municipalities. Agreements were executed between the Commission and the Cities of Port Arthur and Fort William on May 17 and October 10, 1917, respectively, and an Order-in-Council was passed accordingly, providing the necessary funds and authorizing the Commission to proceed with the construction work.

The elevation of Lake Nipigon above the mean tide water level is 852, whereas that of Lake Superior at the mouth of the Nipigon River is 602, making a total difference of 250 feet between the two lakes.

The various sites at which the development is possible on the Nipigon River are given in the accompanying illustration, the total potentiality of the stream varying from approximately 100,000 horsepower, based on continuous flow, to 200,000 horsepower at 50 per cent. load factor. The site chosen by the Commission for the initial development is located at the foot of Lake Jessie near Cameron's Pool.

The hydraulic layout involves the construction of a solid concrete dam with rollways and sluice gates in the centre section and wing walls on either side. The total length of the dam is approximately 300 feet, being 60 feet in height at the maximum

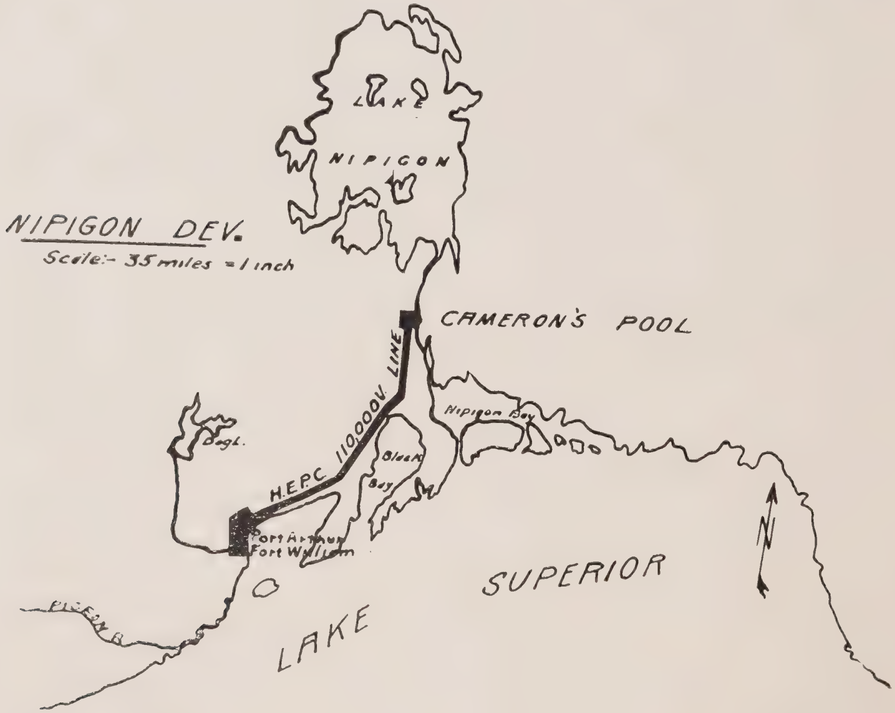
section, and involves the use of approximately 17,000 cubic yards of concrete. Three earth dams will be required in addition to the main dam.

The forebay will occupy an opening in the natural rock walls of the stream and will be approximately 300 feet in length. The powerhouse will be of concrete construction and is designed for an installation of six units. The forebay, headworks, powerhouse excavation and tailrace will be completed for the full development.

The ultimate capacity of the plant will be 75,000 horsepower; only two units, however, will be installed at the present time.

The turbines are being supplied by the I. P. Morris Company, of Philadelphia, Pa., and are now ready for shipment. They are rated at 12,500 horsepower at 72 feet head, 120 R.P.M. These turbines will be vertical type, single runner, with concrete spiral cases.

The generators are rated at 10,600 Kva., at 80 per cent. power factor, 12,000 volts, 3-phase, 60 cycles, each unit being equipped with a direct-connected 125-kw., 250-volt exciter. A spare motor-generator exciter will be provided consisting of a 185-horsepower, 3-phase, 500-volt, squirrel-cage motor, driving a 125-Kw., D.C. generator. The first generator is due for shipment May 15, 1920, and as the work in connection with this machine is progressing very favorably



Plan of Thunder Bay District, showing route of Transmission Line and Location of Development

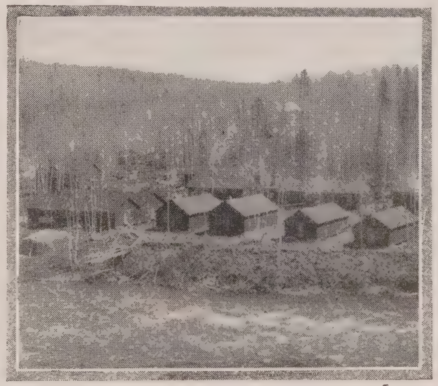
Cameron's Pool, showing Flume and Powerhouse of Temporary Development

at the factory, it is anticipated that delivery will be made according to contract. The second machine is to be delivered on July 1, 1920. These generators are being supplied by the Canadian Westinghouse Company.

The electrical energy at the generating station will be transformed from 12,000 to 110,000 volts, for the purpose of transmission to Port Arthur and Fort William. The step-up transformers consist of a bank of three 8,000-Kva. units with one spare. These transformers are oil insulated, water cooled; the primary voltage is 12,000, secondary voltage 63,500 at full load 80 per cent. power factor, and will be Y-connected on the secondary side.

The electrical layout of the powerhouse provides for a double 12,000 volt bus with an oil breaker between each generator and the bus, and an additional oil breaker between the bus and each transformer bank. One 110,000-volt outgoing feeder will comprise the initial installation; the completed plans, however, provide for three such outgoing lines. The electrical equipment at the powerhouse is so arranged that two generating units, one transformer bank and one outgoing 110,000-volt line, constitute a separate and distinct unit ; consequently the completed development will consist of three such distinct units, making a total of six generators, three banks of transformers and three outgoing lines.

At the main terminal station at the receiving end of the line, which will probably be located at a point central to the two cities, provision will be made for one 110,000-volt bus with two 22,000-volt buses, one being a main bus and the other an emergency bus. This arrangement permits each outgoing 22,000-volt feeder to be equipped with one oil-switch for connection to the main bus and one set of selector disconnecting switches for connection to the emergency bus. The emergency bus will be connected to the main bus through an oil breaker, and should it be necessary under operating con-



Construction Camp Buildings, Nipigon Development

ditions to cut out one of these feeders on account of trouble or for the purpose of making repairs, this feeder will be transferred to the emergency bus by the closing of the oil breaker between the emergency and the main bus, the closing of the selector disconnecting switches between the feeder and the emergency bus, and the opening of the oil breaker between the feeder and the main bus.

The transformer equipment at the receiving station will consist of banks of three 4,000-Kva. units with one bank comprising the initial installation. These transformers will be oil-insulated, water-cooled, 63,500 volts at full load, 80 per cent. power factor Y-connected on the primary side and 22,000 volts on the secondary side.

More complete details of both the hydraulic and electrical equipment at the development and the special features of the receiving station will be given in an article which will appear in The Bulletin at a future date.

Construction work at the development site was begun by the Commission during the month of December, 1918, with a force of about 50 men, this number being gradually increased according to progress made until a maximum of 675 was reached.

Due to the location of the development considerable work of a preliminary nature was found necessary before proceeding with the construction of permanent works, such as the construction of a temporary power plant, one mile of railway siding (standard gauge), including a bridge across the river, as well as various camp buildings and cottages for the purpose of providing living quarters for the staff and the workmen. The temporary power plant consists of two turbines obtained from the old Otonabee Plant near Peterborough, which are utilized to drive one 350-Kw. generator and three Ingersoll compressors of 200-horsepower each. The electric generator provides energy for lighting camp buildings and operating motor driven pumps, whereas the compressors supply air for operating rock drills. The temporary powerhouse building consists of a concrete substructure with frame superstructure. Water is supplied to the turbines through a timber flume 200 feet in length with the intake end submerged directly in the rapids of the river. To avoid ice trouble, considerable of which was experienced during the first few months of operation, this flume was covered with tarpaulin, and in addition to this protection, live steam was introduced at the intake end, all of which was found to give satisfactory results.

The additional construction plant consists of two steam shovels, one No. 60 of 2½ yards capacity, and one No. 50 of 2 yards capacity, together with one Browning locomotive crane, five locomotives, four dump cars and five derricks.

A concrete mixing plant has been constructed which consists of two $^3/_4$-yard mixers with bins above for rock and sand, an elevator for carrying cement to the mixers and a derrick for loading bins. The mixing plant is also equipped with an Insley steel tower, 150 feet in length, with steel chutes. A second mixing plant similar to the one already described

is being installed at the north west corner of the powerhouse site. These two mixing plants will take care of all of the concrete work of the forebay, gate house, wing walls and powerhouse.

A crushing plant has also been constructed with a capacity of 200 tons per day, with the necessary elevator to a screening and washing plant. Arrangements are being made for the erection of a second washing plant, which will be placed at the rock pile in the dump.

The temporary construction plant is also equipped with a machine shop, carpenter shop, car repair shop and grain house.

The camp buildings are very complete, being equipped with electric lights, steam heating and a bathhouse including showers. A hospital with a resident doctor also constitutes part of the camp accommodation, and a private telephone system has been installed connecting all portions of the work. A private telephone line has also been constructed connecting the camp buildings with the Village of Nipigon.

Up to March 31, 1920, 173 acres of land have been cleared, 64,000 cubic yards of solid rock excavation made, 74,000 cubic yards of earth excavation completed and 8,000 cubic yards of rock crushed. These figures do not include any work in connection with the temporary powerhouse or the permanent railway, or the bridge across the river, but constitute excavation which has been made in connection with the powerhouse, forebay and gatehouse.

The approximate cost of the temporary power plant was $46,000, whereas the machinery which has been installed and is being used for construction purposes, represents an outlay of $18,000. The cost of the railway from the main line of the Canadian Northern Railway to the camp site was $31,000, and the cost of the railway bridge across the river approximately $24,000.

The transmission line will consist of a single three-phase circuit, the conductor being of No. 4/0 steel reinforced aluminum, and will be approximately 67 miles in length from the generating station at Cameron's Falls to the Port Arthur receiving station. Provision is being made for an additional transmission line, which will be erected after the completion of the first circuit.

The transmission line between the powerhouse and the Twin Cities will consist of wood pole construction utilizing 45-foot Western Cedar poles, with suspension type insulators and a cross-arm arrangement as per the accompanying sketch. Poles are spaced approximately 325 feet apart and have been erected on a private right-of-way.

The construction of the transmission line was begun in March, 1919, with five gangs of men, consisting of three pole-erecting gangs and two wire-stringing gangs, the entire force consisting of a maximum of 150 men. Poles have already been erected from the easterly limits of Port Arthur to Sprucewood, a distance of sixty miles.

The route of the transmission lines follows the Canadian Northern Railway for approximately fifteen miles after leaving the development, from thence follows a cross country route

to a point near the Canadian Pacific Railway near Loon, from Loon to Sprucewood the route parallels the Canadian Pacific Railway. Approximately 25 per cent. of the poles are erected in rock. It was found necessary to clear practically the entire right-of-way from the development to Port Arthur. The width of the clearing varies from 80 to 100 feet. Brush was found in most sections but very heavy timber was encountered from Sprucewood north. It is expected that the first circuit of this transmission line will be completed on July 1, 1920. The accompanying sketch illustrates the relative position of the development with respect to the Twin Cities, and also gives the route followed by the transmission line.

From a survey which has been made in connection with the existing and future loads in the City of Port Arthur, it is estimated that the possible demand will approximate a connected load of 18,000 horsepower. This load will consist of electrical energy supplied to ten terminal grain elevators, two of which are now being operated by steam and one of which is being converted from steam to electric drive. Energy is also being supplied at the present time to the City Waterworks, Port Arthur Drydock and Shipbuilding Company, Port Arthur Pulp & Paper Company, the Street Railway System and numerous smaller consumers. An additional pulp and paper industry is negotiating with the municipality at the present time for 6,000 horsepower to be used within the limits of the city, while the Hydro-Electric Power Commission has been negotiating with three different pulp and paper industries, the location of which has not yet been definitely determined, each of which will require an initial installation of from 10,000 to 13,000 horsepower. The present demand at Port Arthur approximates 6,000 horse power, but on account of additional load coming on the demand of the municipality on the Nipigon Development when power is first delivered will probably approximate 10,000 horsepower.

The present power possibilities of Fort William approximate a connected load of 18,000 horsepower. Some of this load is now being served by individual steam plants, but the greater portion of the electrical energy being supplied in this municipality is obtained from the Kaministiquia Power Company. The load in this municipality consists of twenty terr minal grain elevators, the greate- number of which are being served by the Kaministiquia Power Company at the present time.

Electrical energy is also being supplied to the Ogilvie Flour-Mills, the Canadian Iron Corporation, the Canadian Car Company and various other smaller uses.

Due to the fact that the existing agreement between the City of Fort William and the Kaministiquia Power Company will remain in force for another four years, Nipigon power will be supplied in Fort William up to the expiration of this agreement, to individual customers. At the expiration of the Kaministiquia Power Company's agreement, however, the load now being supplied to the existing municipally owned system of the city will be transferred to the Hydro System.

The Lineman's Belt

"I know it is in poor shape, but I will take a chance for today."—He did. He fell and when he struck the ground, broke his neck.

The above short paragraph together with the accompanying photo tells in a few words the result of someone's thoughtlessness.

You men whose duties compel you to work on poles or structures, consider this accident. The tool belt and safety strap are for your convenience and protection.

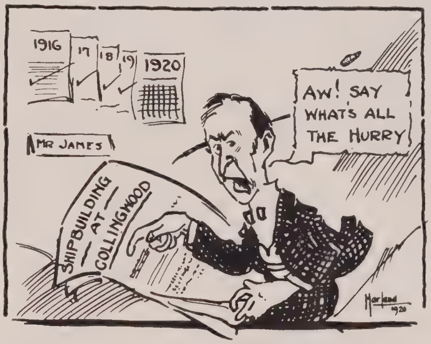
Do not use them if defective.

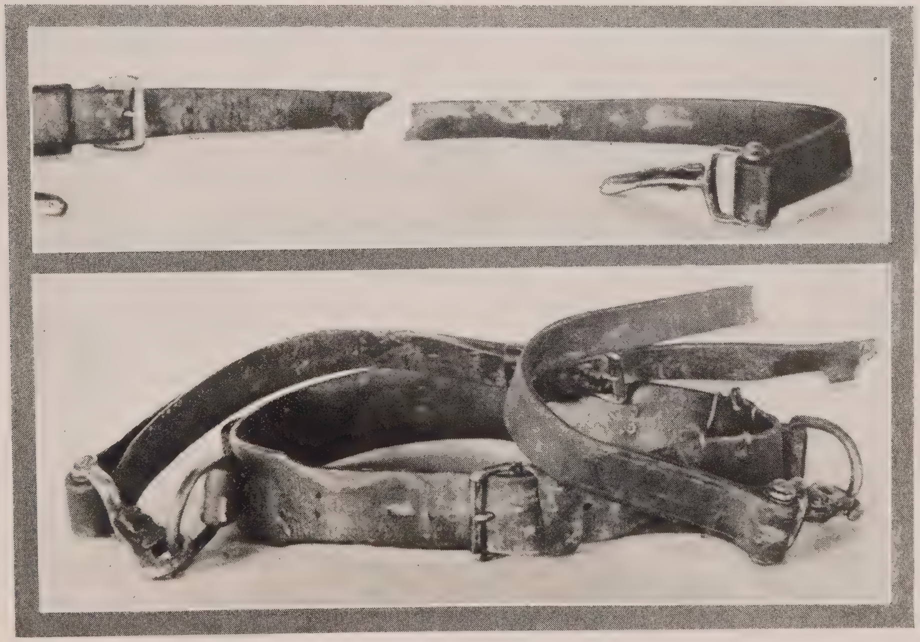
See that your safety strap is not worn too thin.

Examine the snaps and see that the spring catch is not sticking.

Look at the D rings and watch for any ripping of the stitching.

You foremen and men in charge of men, it is your duty to make periodical inspections of the climbing equipment of your men. If any is found to be defective, do not allow it to be used. Better to do without the services of a man for a few hours than to have an accident.





A bit of forethought on the workman's part would have saved his life. Don't use defective belts and straps!

A Circular Letter from the Commission to Hydro Municipalities Regarding Insurance

Dear Sirs:

The question of Employers' Liability Insurance in connection with municipally owned distribution systems is a most important once, and in view of the fact that the companies handling this class of insurance have increased their rates very considerably during the past few years, the Commission is of the opinion that under present conditions it would be advisable to carry this part of your system's insurance with the Workmen's Compensation Board.

At the present time the following rates are given by various insurance companies for insurance in connection with electrical distribution systems:

Employers' Liability Insurance	$7.50
per $100 of payroll, with a minimum premium of $100.	
Insurance to cover Medical Aid	1.00
per $100 of payroll, with a minimum premium of $10.00.	
Public Liability Insurance	2.75
per $100 of payroll, with a minimum premium of $50.00.	
Total	$11.25

The rate given by the Workmen's Compensation Board for Employers' Liability Insurance, including Medical Aid, is $2.00 per $100.00 of payroll, with no minimum premium. This rate, of course, may vary from year to year depending on the number of accidents during the year in connection with this class of risk.

EXAMPLE (1)—(System with Payroll of $300.00 per Year).

Company Insurance on all risks.			Workmen's Compensation Board rate on Employers' Liability and Company Insurance on Public Liability.		
Employees	at 7½%	$100.00		at 2 %	$ 6.00
Medical Aid	at 1 %	10.00	Included in 2%.		
Public	at 2¾%	50.00		at 2¾%	50.00
Total		$160.00	Total		$56.00

EXAMPLE (2)—(System with Payroll of $5,000.00 per Year).

Company Insurance on all risks.			Workmen's Compensation Board rate on Employers' Liability and Company Insurance on Public Liability.		
Employees	at 7½%	$375.00		at 2%	$100.00
Medical Aid	at 1 %	50.00	Included in 2%.		
Public	at 2¾%	137.50		at 2¾%	137.50
Total		$562.50	Total		$237.50

Under date of April 8, 1920, a letter was received by the Commission from one of the companies stating that it is now prepared to give the following rate for Employers' Liability Insurance:

> "Covering fully under the Workmen's Compensation Act, rate $4.00 on each $100.00 of wages paid. (This rate includes Medical Aid). This replaces the former rate of $8.50.
>
> The Annual minimum premium for Employers' Liability Insurance is $125.00; for Public Liability $50.00, and when the two risks are combined $150.00."

These company rates applied as in Example (1) give a total annual premium of $150, and when applied in Example (2) give a total annual premium of $337.50.

We would suggest, therefore, that you make application to the Workmen's Compensation Board to have your Employers' Liability Insurance and Medical Aid carried by them under their schedule. It would also be necessary of course, for you to continue to carry Public Liability Insurance with the present companies carrying this type of risk.

We have enclosed with this letter a circular giving Synopsis and Operation of the Workmen's Compensation Act, also a copy of an Address of Mr. Samuel Price, Chairman of the Workmen's Compensation Board, at the Convention of the International Association of Industrial Accident Boards and Commissions.

The Workmen's Compensation Board has advised that a system of Merit Rating is being used, *i.e.*, should the cost of carrying insurance for any particular system go beyond a certain percentage of cost of accidents, because of carelessness or neglect of safety conditions, an additional charge above standard rate will be made, and a rebate from the standard rate will be made to systems or employers where the cost of carrying the insurance is less than such percentage of costs of accidents.

In conclusion we would say that it is absolutely necessary that every Hydro-Electric System be completely covered by insurance, as a serious accident in connection with your System if no insurance were carried would place a very heavy burden on it which might continue for years.

We would ask you to kindly reply to this letter, advising what action you propose to take *re* insurance in connection with your Hydro-Electric System, and advise us if further assistance is required.

Yours truly,

[Signed] W. W. POPE,
Secretary.

Hydro News Items

Niagara System

Windsor.—The Sandwich, Windsor & Amherstburg Railway Company, which has been purchased by the Hydro-Electric Power Commission of Ontario on behalf of the Border Municipalities, was taken over on April 1st. The Power and Light Department has been taken over from the Commission by the Windsor Hydro-Electric System, which will continue to operate it at 60 cycles, power being generated by the steam plant which was included in the purchase. Steam for the operation of this plant is supplied by the Canadian Salt Company, of Windsor, which uses the exhaust steam for evaporation purposes after it has passed through the engines.

The 60-cycle customers will be placed on the Hydro System on the completion of the Chippawa Power Development.

General.—The Commission has decided that no new municipalities shall be added to the Niagara System until power is available from the Chippawa Development, and a number of municipalities have been so advised.

Rideau System

General.—An almost complete shut down of the power supply occurred on the Rideau System during the two most severe months of the winter. This was due to the unfortunate necessity of depending on the Rideau Power Company at Merrickville for a supply of power which has grown beyond the company's ability to supply. The storage of the waters of the Rideau is controlled by the Department of Railways and Canals which has to regulate the flow in accordance with the demands of the various power users on the river, and the requirements of navigation in the canal.

In exercising these powers the officials consider that they are justified in letting down large quantities of water during the summer months to a large mill at Ottawa which runs by hydraulic power, and whose heavy power requirements are during the summer months. The flow of the river during the months of last year was consequently far in excess of the power demands of other users higher up the river, including even the Rideau Power Company. Representations were made to Ottawa and a deputation from the towns of Smith's Falls and Perth waited on the Minister of Railways and Canals, but little satisfaction was obtained.

This wastage of water during the summer months, combined with an unusually severe winter, reduced the river flow to such a degree that on January 9th the supply of power from the Rideau Power Company dropped to 200 Kw., and on February 12th

no power at all was available. The Towns of Smith's Falls and Perth have been put to very heavy expense in operating their steam plants from January 9th to March 12th, when normal power supply was again resumed. Both the towns have large and growing power loads and it is of the utmost importance that their power users should be protected against a repetition of this power shortage in the future. Fortunately, in the near future the system will cease to depend on the vagaries of the Rideau River and will receive power from the Commission's new development at High Falls on the Mississippi River, where it is hoped that a continuous supply of 3,000 horsepower will be available throughout the year.

High Falls.—Temporary installation is rapidly nearing completion and power will be turned on some time during this month. One unit will be placed in operation.

Kemptville.—Negotiations between the municipality and the Commission have been actively taken up again with a view to getting service to this municipality. Estimates are being prepared on the basis of extending a line from Merrickville.

St. Lawrence System

St. Lawrence System.—General instructions have been issued to proceed with the construction supplying the district including Lancaster, Alexandria and Maxville. This work will be undertaken during the summer months. Distribution systems will be constructed in a number of these municipalities, as no electric service has yet been supplied to them. A resolution has been received from the village of North Augusta requesting estimates on the cost of power.

A number of municipalities, including Newington, Finch and Avonmore, are receiving consideration, and estimates are being prepared on the cost of supplying these municipalities.

The Toronto Paper Company, of Cornwall, has greatly increased its load, owing to the fact that the Canal power in its plant has been temporarily suspended. All of the plant is now being driven by electric power.

Walkerville Hydro Business

By M. J. McHenry, Manager
Walkerville Hydro-Electric System

IT WAS suggested at the Convention of the Association of Municipal Electrical Utilities held in January last, that a statement of the merchandise business of the various municipalities be published in THE BULLETIN, in order that towns serving similar populations could make some satisfactory comparison in business. During the year 1919 the Walkerville Hydro-Electric System has served a population of approximately eleven thousand people and has carried on a business merchandise of considerable magnitude for such a district.

A Hydro Shop was opened in Walkerville in 1917, during which year a total business of approximately twelve thousand dollars was achieved. In 1918 this business was increased to a total amount of twenty-eight thousand dollars for that year, and the results for the year 1919 show a

very satisfactory increase. The total merchandise business in 1919 amounts to sixty-two thousand eight hundred and fifty dollars.

Below is given a synopsis of this business, showing the yearly sales for various lines, appliances and equipments

Article	*Yearly Sales*
Electric Ranges	$12,000
Electric Washing Machines	4,000
Electric Vacuum Cleaners	4,000
Electric Portable Lamps	1,000
Electric Heaters (660 watt)	1,600
Electric Fans	1,500
Electric Irons	1,500
Electric Toasters	900
Electric Percolators	350
Lamp Bulbs	10,000
Miscellaneous Appliances, as Grills, Sewing Machines, Water Heaters, Flashlights, Hot Plates, etc.	4,000
Miscellaneous Appliances, as Sockets, Wire Cord, Fuses, etc.	3,000
Wiring Work and Installing Apparatus	9,000
Induction Motors	10,000
Total	$62,850

It is hoped that this information will be of service to some municipalities who hesitate to start a Hydro shop, and will give them some idea of what can be accomplished in a town of approximately ten thousand population.

NOTICE

TO ELECTRICAL MANUFACTURERS, JOBBERS AND DEALERS

All electrical material, devices and fittings for use on inside electrical installations in the Province of Ontario, *must not be offered for sale* until their design and construction has been approved by the Hydro-Electric Power Commission of Ontario. (6 Geo. V., Chapter 19, 1916)

Manufacturers whose products are approved and listed by other recognized authorities, and which also meet the requirements of this Commission, may have same placed on the approval list by making application in accordance with Approval Laboratories' Bulletin No. 5, a copy of which will be sent upon request.

ONTARIO DEALERS' ATTENTION IS CALLED TO THE FOREGOING REGULATION—WHICH PROHIBITS THE SALE OF UNAPPROVED ELECTRICAL DEVICES.

APPROVAL LABORATORIES

HYDRO-ELECTRIC POWER COMMISSION
OF ONTARIO

8 STRACHAN AVENUE, TORONTO, ONTARIO

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THE BULLETIN

Published by

HYDRO-ELECTRIC POWER COMMISSION
OF ONTARIO

Index to Volume VII.

Hydro Municipalities

NIAGARA SYSTEM

25 Cycles

	Pop.
Acton	1,570
Ailsa Craig	462
Ancaster	400
Ancaster Township	4,577
Aylmer	2,119
Ayr	780
Baden	710
Barton Township	6,061
Beachville	503
Biddulph Township	1,750
Blenheim	1,257
Bolton	727
Bothwell	695
Brampton	4,023
Brantford	26,601
Brantford Township	7,739
Breslau	500
Brigden	400
Burford	700
Burford Township	3,882
Burgessville	300
Caledonia	1,236
Chatham	13,943
Chippewa	707
Clinton	1,981
Comber	800
Copetown	230
Dashwood	350
Delaware	350
Dereham Township	3,176
Dorchester	400
Dorchester S. Tp.	1,457
Drayton	613
Dresden	1,403
Drumbo	400
Dublin	218
Dundas	4,834
Dunnville	3,286
Dutton	840
Elmira	2,065
Elora	1,005
Embro	472
Etobicoke Township	5,822
Exeter	1,504
Fergus	1,679
Flamborough E. Tp.	2,229
Forest	1,421
Galt	11,920
Georgetown	1,654
Goderich	4,553
Grantham Township	3,133
Granton	300
Guelph	16,022
Hagersville	1,053
Hamilton	104,491
Harriston	1,563
Hensall	717
Hespeler	2,887
Highgate	427
Ingersoll	5,300
Kitchener	19,380
Lambeth	350
Listowel	2,291
London	57,301
London Township	6 024
Louth Township	2,212
Lucan	643
Lynden	662
Markham	909
Merriton	1,670
Milton	1,947
Milverton	929
Mimico	2,004
Mitchell	1,656
Moorefield	335
Mount Brydges	500
New Hamburg	1,398
New Toronto	1,423
Niagara Falls	11,715
Niagara-on-the-Lake	1,318
Norwich	1.093
Norwich N. Township	2,029
Norwich S. Township	1,907
Oil Springs	537
Otterville	500
Palmerston	1,843
Paris	4,437
Petrolia	3,047
Plattsville	550
Point Edward	937
Port Colborne	1,624
Port Credit	1,179
Port Dalhousie	1,318
Port Stanley	831
Preston	5,284
Princeton	600
Ridgetown	2,080
Rockwood	650
Rodney	626
Sandwich	3,077
Sarnia	12,323
Scarborough Township	5,525
Seaforth	2,075
Simcoe	4,032
Springfield	422
St. Catherines	17,917
St. George	600
St. Jacobs	400
St. Mary's	3,960
St. Thomas	17,216
Stamford Township	3,418
Stratford	17,371
Strathroy	2,816
Streetsville	500
Tavistock	974
Thamesford	504
Thamesville	742
Thorndale	250
Tilbury	1,605
Tillsonburg	3,059
Toronto	460,526
Toronto Township	5,008
Townsend Township	3,268
Vaughan Township	4,059
Walkerville	5,349
Wallaceburg	4,107
Waterdown	696
Waterford	1,027
Waterloo	5,091
Waterloo Township	6,538
Watford	1,115
Welland	7,905
West Lorne	708
Wellesley	583
Weston	2,283
Windsor	26,524
Woodbridge	615
Woodstock	10,004
Wyoming	526
Zurich	450
Total	1,063.104

SEVERN SYSTEM

60 Cycles

Alliston	1,237
Barrie	6,866
Beeton	588
Bradford	946
Camp Borden	......
Coldwater	617
Collingwood	7,010
Cookstown	635
Creemore	599
Elmvale	775
Midland	7,109
Orillia	7,448
Penetang	3,672
Port McNichol	500
Stayner	990
Thornton	250
Tottenham	557
Victoria Harbor	1,542
Waubaushene	600
Total	41,941

WASDELL'S SYSTEM

60 Cycles

Beaverton	821
Brechin	215
Cannington	746
Sunderland	570
Woodville	357
Total	2,709

NIPISSING SYSTEM

60 Cycles

Callander	650
Nipissing	400
North Bay	9,651
Powassan	572
Total	11.273

MUSKOKA SYSTEM

60 Cycles

	Pop.
Gravenhurst	1,600
Huntsville	2,135
Total	3,735

EUGENIA SYSTEM

60 Cycles

Alton	700
Artemesia Township	2,396
Arthur	1,003
Chatsworth	286
Chesley	1,860
Dundalk	750
Durham	1,520
Elmwood	500
Flesherton	428
Grand Valley	586
Hanover	3,310
Holstein	285
Horning's Mills	350
Kylsyth	......
Markdale	904
Mount Forest	1,871
Neustadt	470
Orangeville	2,381
Owen Sound	11,819
Shelburne	1,018
Tara	620
Total	33,057

OTTAWA SYSTEM

60 Cycles

Ottawa	100,561

THUNDER BAY SYSTEM.

60 Cycles

Port Arthur	15,224

CENTRAL ONTARIO SYSTEM

60 Cycles

Belleville	12,080
Bloomfield	523
Bowmanville	3,545
Brighton	1,278
Cobourg	4,457
Colborne	811
Deseronto	2,061
Kingston	22,265
Lindsay	7,752
Madoc	1,114
Millbrook	746
Napanee	2,881
Newburgh	444
Newcastle	600
Omemee	446
Orono	700
Oshawa	8,812
Peterboro	28,996
Picton	3,408
Port Hope	4,486
Stirling	823
Trenton	5,169
Tweed	1,350
Wellington	829
Whitby	2,902
Total	118,478

ST. LAWRENCE SYSTEM

60 Cycles

Brockville	9,473
Chesterville	868
Prescott	2,630
Williamsburg	100
Winchester	1,042
Total	14,113

RIDEAU SYSTEM

60 Cycles

Carlton Place	3,706
Perth	3,358
Smith's Falls	6,115
Total	13,179

ESSEX COUNTY SYSTEM

25 Cycles

Amherstburg	1,990
Canard River	50
Cottam	100
Essex	1,429
Harrow	375
Kingsville	1,633
Leamington	3,604
Total	9.181

THOROLD SYSTEM

25 Cycles

Thorold	2,373

THE aim of The Bulletin is to provide municipalities with a source of information regarding the activities of the Commission; to provide a medium through which matters of common interest may be discussed, and to promote a spirit of co-operation between Hydro Municipalities.